PATENT ABSTRACTS OF JAPAN

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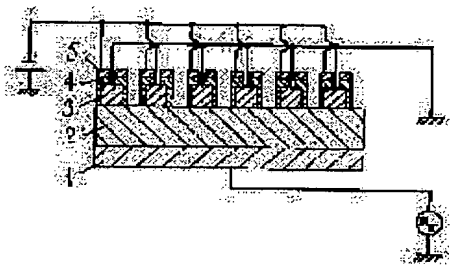
(54) FERROELECTRIC COLD CATHODE

(57)Abstract:

PURPOSE: To provide a ferroelectric cold cathode having a ferroelectric substance sandwiched by electrodes and emitting electrons when the alternating electric field is applied between the electrodes.

CONSTITUTION: A ferroelectric cold cathode is constituted of a ferroelectric substance 2, the first electrode 1 formed on one face of the ferroelectric substance 2, and the second electrode 3 formed on the other face of the ferroelectric substance 2, the surface layer of the ferroelectric substance 2 and other portions differ in electrical resistivity, and a practical cold cathode having a stable electron emission characteristic is obtained.



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(43)公開日　平成５年(1993)12月10日

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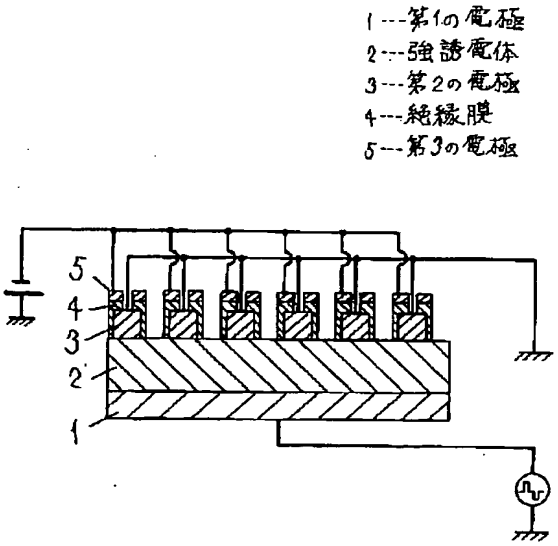
(54)【発明の名称】　強誘電体冷陰極

(57)【要約】
【目的】　強誘電体を電極によりサンドイッチ構造とし、電極間に交番電界を印加する事により電子放出を行う強誘電体冷陰極を提供する。
【構成】　強誘電体２と前記強誘電体の一方の面に形成された第１の電極１と前記強誘電体の他方の面に形成された第２の電極３とからなる強誘電体冷陰極に於いて前記強誘電体の表面層とその他の部分の抵抗率が異なっているので電子放出特性の安定した実用的な冷陰極が得られる。



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【特許請求の範囲】

【請求項１】　強誘電体と前記強誘電体の一方の面に形成された第１の電極と前記強誘電体の他方の面に形成された第２の電極とからなる強誘電体冷陰極に於いて前記強誘電体の表面層とその他の部分の抵抗率が異なっている強誘電体冷陰極。

【請求項２】　強誘電体と前記強誘電体の一方の面に形成された第１の電極と前記強誘電体の他方の面に形成された第２の電極とからなる強誘電体冷陰極に於いて前記第１の電極と前記第２の電極間に間欠的に前記強誘電体の絶縁破壊電圧以上の電圧を印加する事を特徴とする強誘電体冷陰極。

【請求項３】　強誘電体と前記強誘電体の一方の面に形成された第１の電極と前記強誘電体の他方の面に形成された第２の電極とからなる強誘電体冷陰極に於いて前記第１の電極または第２の電極を分割し、分割した電極間に電位差を与えることを特徴とする強誘電体冷陰極。

【請求項４】　強誘電体と前記強誘電体の一方の面に形成された第１の電極と前記強誘電体の他方の面に形成された第２の電極とからなる強誘電体冷陰極に於いて前記第２の電極上に形成された絶縁膜と前記絶縁膜上に形成された、前記第２の電極の電位よりも低い電位である第３の電極とからなる強誘電体冷陰極。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は電子ビームを放出する強誘電体冷陰極に関するものである。

【０００２】

【従来の技術】図４は従来の電子ビームを放出する強誘電体冷陰極であり、例えばH．Ｇｕｎｄｅｌ等によって報告されたものである。（ジャーナル　オブ　アプライド　フィジックス　６９（２），Ｐｐ９７５’９１）４１は第１の電極、４２は強誘電体、４３は第２の櫛形電極である。

【０００３】以上のように構成された従来の強誘電体冷陰極に於いて、第１の電極４１と第２の櫛形電極４３の間に交番電界を印加すると強誘電体４２内部に印加された電界を打ち消すような向きに分極が生じ、この分極が印加交番電界の変化に伴って反転する際に第２の櫛形電極４３の近傍に存在する電子をクーロン力により弾き飛ばし電子放出を行う。

【０００４】

【発明が解決しようとする課題】しかしながら上記のような構成では、第２の櫛形電極４３の近傍に存在する電子の供給減は、周囲の電離したガスや第２の櫛形電極４３から浸みだした電子と考えられているが、不明確であり制御も難しいので電子放出特性の安定した実用的な電子放出源としては使えないという問題点を有していた。更に、飛び出した電子の一部は第２の櫛形電極４３に吸収されてしまい電子放出の効率が落ちるという問題点も

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有していた。

【０００５】本発明はかかる点に鑑み、実用的な電子放出源としての強誘電体冷陰極を提供することを目的とする。

【０００６】

【課題を解決するための手段】本発明の第１の発明は、強誘電体と前記強誘電体の一方の面に形成された第１の電極と前記強誘電体の他方の面に形成された第２の電極とからなる強誘電体冷陰極に於いて前記強誘電体の表面層近傍の抵抗率を制御する手段とからなるものである。

【０００７】また、本発明の第２の発明は、強誘電体と前記強誘電体の一方の面に形成された第１の電極と前記強誘電体の他方の面に形成された第２の電極とからなる強誘電体冷陰極に於いて前記第１の電極と前記第２の電極との間欠的に前記強誘電体の絶縁破壊電圧以上の電圧を印加する事を特徴とする強誘電体冷陰極である。

【０００８】また、本発明の第３の発明は、強誘電体と前記強誘電体の一方の面に形成された第１の電極と前記強誘電体の他方の面に形成された第２の電極とからなる強誘電体冷陰極に於いて前記第２の電極を分割し、分割した電極間に電位差を与えることを特徴とする強誘電体冷陰極である。

【０００９】また、本発明の第４の発明は、強誘電体と前記強誘電体の一方の面に形成された第１の電極と前記強誘電体の他方の面に形成された第２の電極とからなる強誘電体冷陰極に於いて前記第２の電極上に形成された絶縁膜と前記絶縁膜上に形成され、前記第２の電極の電位よりも低い電位である第３の電極とからなるものである。

【００１０】

【作用】本発明の第１の作用は強誘電体表面層近傍の抵抗率を制御することにより、電極から強誘電体への電子供給量を制御すると共に、電極の極性が反転したときに浸みだした電子が電極に戻る時間を分極反転の時間よりも長くすることにより安定な電子放出を行う。

【００１１】本発明の第２の作用は電極間に間欠的に強誘電体の絶縁破壊電圧以上の電圧を印加することにより、強誘電体中に電流を流し印加電圧が絶縁破壊電圧よりも低くなったときに強誘電体内に残った電子を電子供給源として利用するものである。

【００１２】本発明の第３の作用は強誘電体の一方の面に設けられた電極を分割し電極間に電位差を与えることにより強誘電体表面上で沿面放電を生じさせ電圧が低くなったときに表面に残った電子を電子供給源として利用するものである。

【００１３】本発明の第４の作用は強誘電体から飛び出した電子よりも電極の電位を低くすることにより電子が電極に吸収されることを防止するものである。

【００１４】

【実施例】

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（実施例1）図1は本発明の第1の実施例に於ける強誘電体冷陰極の構成図を示すものである。1は第1の電極であり例えば強誘電体2にスパッタ等により成膜されている。2は強誘電体であり例えばPZT（Pb（Zr，Ti）O_3、PLZT（（Pb，La）（Zr，Ti）O_3）$BaTiO_3$等である。強誘電体2内部には不純物（例えばSb，Mo，Ta，Nb，V，W等）を導入したり、結晶成長中の温度や圧力等の条件を変えることにより、結晶欠陥が生じている。3は第2の電極であり、櫛形構造になっており、接地されている。4は絶縁膜であり酸化シリコン等の膜である。5は絶縁膜4上に設けられた第3の電極であり、接地電位よりも低い電位になっている。

【0015】以上のように構成された第1の実施例の強誘電体冷陰極について、以下その動作を説明する。第1の電極1に交番電界を印加する第1の電極1が正極性になった時に第2の電極3から強誘電体2の結晶欠陥を通じて電子が強誘電体2の表面に供給される。供給された電子は強誘電体2の分極により、表面近傍にトラップされる。次に第1の電極1が負極性になるとトラップされていた電子は第2の電極3に戻ろうとするが電子の移動よりも速く強誘電体2の分極が反転し表面近傍にトラップされていた電子がクーロン力により弾き飛ばされ、電子放出が行われる。第2の電極3は絶縁膜4に覆われており、絶縁膜4上には接地電位よりも低い電位を持つ第3の電極5があるので放出電子は第2の電極3および第3の電極5に吸収されることなく飛び出すことになるので電流量を多くすることができる。交番電界が正負反転する毎に上記のサイクルが行われ、安定した電子放出が行われることになる。

【0016】以上のように第1の実施例によれば、結晶欠陥を導入した強誘電体を用いることにより安定した電子放出源としての強誘電体冷陰極を得ることができる。更に第3の電極を接地電位よりも負電位にすることにより、放出する電流量を多くすることができる。なお、上記実施例に於いて強誘電体に結晶欠陥を導入して表面層の抵抗率を制御する代わりに強誘電体2の表面にセシウム等の仕事関数の低い物質を島状に成膜することにより、強誘電体表面層の抵抗率を制御すると共に、電子放出量を多くする事ができる。

【0017】（実施例2）図2は本発明の第2の実施例に於ける強誘電体冷陰極の構成を示す図である。21は第1の電極であり、22は強誘電体であり実施例1に述べたものと同様の材料からなる。23は第2の電極であり、1μmラインアンドスペースの櫛形電極構造になっている。上記のように構成された強誘電体冷陰極について、以下その動作を説明する。まず、第1の電極21と第2の電極23の間に強誘電体22の絶縁破壊電圧以上の電圧、即ち電界強度にして10MV／cm程度を印加すると強誘電体22中を電流が流れる。次に電圧を下げて

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いくと強誘電体22は再び絶縁物となり、この時、強誘電体22内部に存在する電子はトラップされる。次に第1の電極21と第2の電極23間に交番電界を印加すると強誘電体内部にトラップされていた余剰電子は強誘電体22の分極の効果により放出される。以上のように第1の電極21と第2の電極23間に交番電界に加えて間欠的に絶縁破壊電圧以上の電圧を印加する事により、効果的に強誘電体22に電子を供給することができる。

【0018】（実施例3）以下本発明の第3の実施例について図面を参照しながら、説明する。

【0019】図3に於いて31は第1の電極であり、32は強誘電体であり実施例1に述べたものと同様の材料からなる。33a，33bは第2の電極であり、電極33bは接地されている。

【0020】上記のように構成された強誘電体冷陰極について、以下その動作を説明する。まず、第1の電極31と第2の電極33a間に電界を印加すると強誘電体32中に分極が生じるがこの時第2の電極33aと同33b間には沿面放電が生じ強誘電体32表面を電流が流れる。次に第2の電極33aの電位が接地電位に近づくと沿面放電は消滅しこの際、強誘電体32表面に電子がトラップされる。次に逆極性の電圧を第1の電極31と第2の電極33aの間に印加すると強誘電体32内部の分極が逆転し表面にトラップされていた電子はクーロン力により弾き飛ばされ、電子放出が生じる。

【0021】以上のように第2の電極を分割し双方の電位を異ならせることにより、強誘電体表面に電子供給を行い、安定した特性の強誘電体冷陰極を得ることができる。

【0022】

【発明の効果】以上のように本発明の第1の発明によれば、表面層の抵抗率を制御した強誘電体を電極でサンドイッチ構造にすることにより、安定した電子放出特性の強誘電体冷陰極を得ることができる。

【0023】また、本発明の第2の発明によれば、強誘電体中にリーク電流を流して電子を供給することにより、安定した電子放出特性の強誘電体冷陰極を得ることができる。

【0024】また、本発明の第3の発明によれば、強誘電体表面だけに沿面放電を生じさせるので、強誘電体にダメージを与えることなく電子を供給することができる。

【0025】また、本発明の第4の発明によれば、強誘電体表面から放出された電子が電極に吸収されることなく出てくるので、電流量を多く取れる。

【図面の簡単な説明】

【図1】本発明の第1の実施例に於ける強誘電体冷陰極の構成図

【図2】本発明の第2の実施例に於ける強誘電体冷陰極の構成図

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【図３】本発明の第３の実施例に於ける強誘電体冷陰極の構成図

【図４】従来の強誘電体冷陰極の構成図

【符号の説明】

1　第１の電極

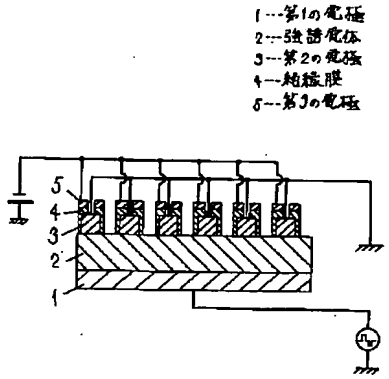
2　強誘電体

3　第２の電極

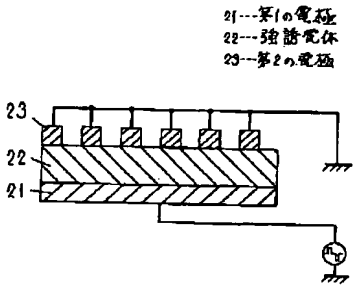
4　絶縁膜

5　第３の電極

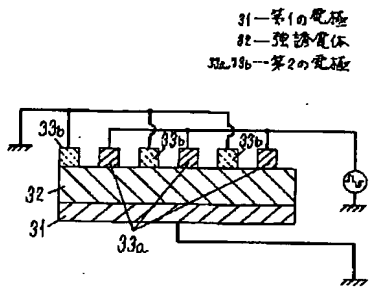
【図１】



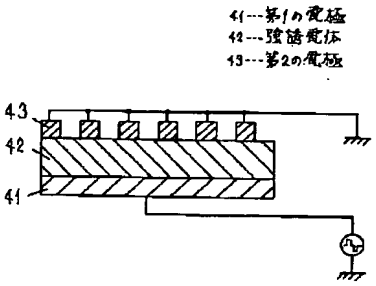
【図２】



【図３】



【図４】



JAPANESE [JP,05-325777,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS OPERATION EXAMPLE DESCRIPTION OF DRAWINGS DRAWINGS

[Translation done.]

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CLAIMS

[Claim(s)]
[Claim 1] Ferroelectric cold cathode from which the resistivity of the surface layer of said ferroelectric and other parts differs in the ferroelectric cold cathode which consists of the 1st electrode formed in one field of a ferroelectric and said ferroelectric, and the 2nd electrode formed in the field of another side of said ferroelectric.
[Claim 2] Ferroelectric cold cathode characterized by impressing the electrical potential difference more than the dielectric breakdown voltage of said ferroelectric to inter-electrode [said / 1st electrode and inter-electrode / 2nd / said] intermittently in the ferroelectric cold cathode which consists of the 1st electrode formed in one field of a ferroelectric and said ferroelectric, and the 2nd electrode formed in the field of another side of said ferroelectric.
[Claim 3] Ferroelectric cold cathode characterized by giving the potential difference to inter-electrode [which divided and divided said the 1st electrode or 2nd electrode in the ferroelectric cold cathode which consists of the 1st electrode formed in one field of a ferroelectric and said ferroelectric, and the 2nd electrode formed in the field of another side of said ferroelectric].
[Claim 4] Ferroelectric cold cathode which consists of an insulator layer formed on said 2nd electrode in the ferroelectric cold cathode which consists of the 1st electrode formed in one field of a ferroelectric and said ferroelectric, and the 2nd electrode formed in the field of another side of said ferroelectric, and the 3rd electrode which is the potential lower than the potential of said 2nd electrode formed on said insulator layer.

[Translation done.]

JAPANESE [JP,05-325777,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS OPERATION EXAMPLE DESCRIPTION OF DRAWINGS DRAWINGS

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the ferroelectric cold cathode which emits an electron beam.
[0002]
[Description of the Prior Art] Drawing 4 is ferroelectric cold cathode which emits the conventional electron beam, for example, is reported by H.Gundel etc. (Journal OBU applied physics 69 (2) Pp 975'91) As for the 1st electrode and 42, 41 is [a ferroelectric and 43] the 2nd Kushigata electrode.
[0003] In the conventional ferroelectric cold cathode constituted as mentioned above, if an alternating electric field is impressed between the 1st electrode 41 and the 2nd Kushigata electrode 43, in case polarization will arise in sense which negates the electric field impressed to the ferroelectric 42 interior and this polarization will be reversed with change of an impression alternating electric field, the electron which exists near the 2nd Kushigata electrode 43 is flipped off according to Coulomb force, and electron emission is performed.
[0004]
[Problem(s) to be Solved by the Invention] However, with the above configurations, although the decrease of supply of the electron which exists near the 2nd Kushigata electrode 43 was considered to be the electron which it begun to permeate from gas and the 2nd Kushigata electrode 43 which the perimeter ionized, since it was indefinite and control was also difficult, it had the trouble that it could not use as a practical source of electron emission by which the electron emission characteristic was stabilized. Furthermore, some electrons which jumped out will be absorbed by the 2nd Kushigata electrode 43, and it also had the trouble that the effectiveness of electron emission fell.
[0005] This invention aims at offering the ferroelectric cold cathode as a practical source of electron emission in view of this point.
[0006]
[Means for Solving the Problem] Invention of the 1st of this invention consists of a means to control the resistivity near the surface layer of said ferroelectric in the ferroelectric cold cathode which consists of the 1st electrode formed in one field of a ferroelectric and said ferroelectric, and the 2nd electrode formed in the field of another side of said ferroelectric.
[0007] Moreover, invention of the 2nd of this invention is ferroelectric cold cathode characterized by the thing of said 1st electrode and said 2nd electrode for which the electrical potential difference more than the dielectric breakdown voltage of said ferroelectric is impressed intermittently in the ferroelectric cold cathode which consists of the 1st electrode formed in one field of a ferroelectric and said ferroelectric, and the 2nd electrode formed in the field of another side of said ferroelectric.
[0008] Moreover, invention of the 3rd of this invention is ferroelectric cold cathode characterized by giving the potential difference to inter-electrode [which divided and divided said 2nd electrode in the ferroelectric cold cathode which consists of the 1st electrode formed in one field of a ferroelectric and said ferroelectric, and the 2nd electrode formed in the field of another side of said ferroelectric].
[0009] Moreover, invention of the 4th of this invention is formed on the insulator layer formed on said 2nd electrode in the ferroelectric cold cathode which consists of the 1st electrode formed in one field of a ferroelectric and said ferroelectric, and the 2nd electrode formed in the field of another side of said ferroelectric, and said insulator layer, and consists of the 3rd electrode which is potential lower than the potential of said 2nd electrode.
[0010]
[Function] When the electron which it began to permeate when the polarity of an electrode is reversed makes it longer than the time amount of polarization reversal of the time amount which returns to an electrode, the 1st operation of this invention performs stable electron emission, while controlling the electronic amount of supply from an electrode to a ferroelectric by controlling the resistivity near the ferroelectric surface layer.
[0011] By impressing the electrical potential difference more than the dielectric breakdown voltage of a ferroelectric to inter-electrode intermittently, the 2nd operation of this invention uses the electron which remained in the ferroelectric as an electronic source of supply, when sink applied voltage becomes lower than dielectric breakdown voltage about a current into a ferroelectric.
[0012] The 3rd operation of this invention uses the electron which remained in the front face as an electronic source of supply, when creeping discharge is produced and an electrical potential difference becomes low on a ferroelectric front face by dividing the electrode prepared in one field of a ferroelectric, and giving the potential difference to inter-electrode.

[0013] The 4th operation of this invention prevents that an electron is absorbed by the electrode by making potential of an electrode lower than the electron which jumped out of the ferroelectric.
[0014]
[Example]
(Example 1) Drawing 1 shows the block diagram of the ferroelectric cold cathode in the 1st example of this invention. 1 is the 1st electrode, for example, is formed by the ferroelectric 2 by the spatter etc. 2 is a ferroelectric, for example, is PZT (they are Pb(Zr, Ti) O3 and PLZT(O(Zr (Pb, La), Ti) 3) BatIO3 grade.). The crystal defect has arisen by introducing impurities (for example, Sb, Mo, Ta, Nb, V, W, etc.) into the ferroelectric 2 interior, or changing conditions, such as temperature in crystal growth, and a pressure. 3 is the 2nd electrode, has the Kushigata structure and is grounded. 4 is an insulator layer and is film, such as silicon oxide. 5 is the 3rd electrode prepared on the insulator layer 4, and has low potential from touch-down potential.
[0015] About the ferroelectric cold cathode of the 1st example constituted as mentioned above, the actuation is explained below. When the 1st electrode 1 which impresses an alternating electric field to the 1st electrode 1 becomes straight polarity, an electron is supplied to the front face of a ferroelectric 2 through the crystal defect of a ferroelectric 2 from the 2nd electrode 3. The trap of the supplied electron is carried out near the front face by polarization of a ferroelectric 2. Next, if the 1st electrode 1 becomes negative polarity, although the electron by which the trap was carried out tends to return to the 2nd electrode 3, polarization of a ferroelectric 2 will be more quickly [than migration of an electron] reversed, the electron by which the trap was carried out near the front face will be flipped off by Coulomb force, and electron emission will be performed. Since the 2nd electrode 3 will jump out without the emission electron being absorbed by the 2nd electrode 3 and 3rd electrode 5 since there is the 3rd electrode 5 which is covered with the insulator layer 4 and has potential lower than touch-down potential on an insulator layer 4, it can make [many] the amount of currents. Whenever an alternating electric field carries out positive/negative reversal, the above-mentioned cycle will be performed and stable electron emission will be performed.
[0016] According to the 1st example, the ferroelectric cold cathode as a source of electron emission stabilized by using the ferroelectric which introduced the crystal defect can be obtained as mentioned above. By more furthermore than touch-down potential making the 3rd electrode into negative potential, the amount of currents to emit can be made [many]. In addition, while controlling the resistivity of a ferroelectric surface layer by forming the low matter of work functions, such as caesium, in the shape of an island on the front face of a ferroelectric 2 instead of introducing a crystal defect into a ferroelectric in the above-mentioned example, and controlling the resistivity of a surface layer, the amount of electron emission can be made [many].
[0017] (Example 2) Drawing 2 is drawing showing the configuration of the ferroelectric cold cathode in the 2nd example of this invention. 21 is the 1st electrode and 22 consists of the same ingredient as what is a ferroelectric and was stated to the example 1. 23 is the 2nd electrode and has the Kushigata electrode structure of 1-micrometer Rhine and a tooth space. About the ferroelectric cold cathode constituted as mentioned above, the actuation is explained below. First, if it carries out to the electrical potential difference more than the dielectric breakdown voltage of a ferroelectric 22, i.e., field strength, and 10 MV/cm extent is impressed between the 1st electrode 21 and the 2nd electrode 23, a current will flow the inside of a ferroelectric 22. Next, if the electrical potential difference is lowered, a ferroelectric 22 will serve as an insulating material again, and the trap of the electron which exists in the ferroelectric 22 interior will be carried out at this time. Next, if an alternating electric field is impressed between the 1st electrode 21 and the 2nd electrode 23, the surplus electron by which the trap was carried out to the interior of a ferroelectric will be emitted by the effectiveness of polarization of a ferroelectric 22. By impressing the electrical potential difference more than dielectric breakdown voltage intermittently between the 1st electrode 21 and the 2nd electrode 23 as mentioned above in addition to an alternating electric field, an electron can be effectively supplied to a ferroelectric 22.
[0018] (Example 3) It explains, referring to a drawing about the 3rd example of this invention below.
[0019] In drawing 3 , 31 is the 1st electrode, and 32 consists of the same ingredient as what is a ferroelectric and was stated to the example 1. 33a and 33b are the 2nd electrode, and electrode 33b is grounded.
[0020] About the ferroelectric cold cathode constituted as mentioned above, the actuation is explained below. First, if electric field are impressed between the 1st electrode 31 and the 2nd electrode 33a, although polarization will arise in a ferroelectric 32, between 2nd electrode 33a and this 33b, creeping discharge arises at this time, and a current flows ferroelectric 32 front face. Next, if the potential of 2nd electrode 33a approaches touch-down potential, creeping discharge will disappear and the trap of the electron will be carried out to ferroelectric 32 front face in this case. Next, if the electrical potential difference of reversed polarity is impressed between the 1st electrode 31 and 2nd electrode 33a, polarization of the ferroelectric 32 interior is reversed, the electron by which the trap was carried out to the front face will be flipped off by Coulomb force, and electron emission will produce it.
[0021] By dividing the 2nd electrode as mentioned above and changing both potentials, electronic supply can be performed on a ferroelectric front face, and the ferroelectric cold cathode of the stable property can be obtained.
[0022]
[Effect of the Invention] According to invention of the 1st of this invention, the ferroelectric cold cathode of the stable electron emission characteristic can be obtained as mentioned above by making into sandwich structure with an electrode the ferroelectric which controlled the resistivity of a surface layer.
[0023] Moreover, according to invention of the 2nd of this invention, the ferroelectric cold cathode of the stable electron emission characteristic can be obtained by passing leakage current and supplying an electron into a ferroelectric.
[0024] Moreover, according to invention of the 3rd of this invention, since only a ferroelectric front face is made to produce creeping discharge, an electron can be supplied, without giving a damage to a ferroelectric.

[0025] Moreover, since it comes out according to invention of the 4th of this invention, without the electron emitted from the ferroelectric front face being absorbed by the electrode, many amounts of currents can be taken.

[Translation done.]

JAPANESE [JP,05-325777,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS OPERATION EXAMPLE DESCRIPTION OF DRAWINGS DRAWINGS

[Translation done.]